February, 2014

Wild Rice Sulfate Standard – Summary of Findings and Preliminary Recommendations
Legislative Briefing Document February, 2014

Background:

In 2011, the Minnesota Legislature appropriated funding and directed the Min
Agency (MPCA) to conduct research on the effects of sulfate and other subs
This research was intended to inform an evaluation of the existing wild . In 1973, the
MPCA adopted and the U.S. Environmental Protection Agency (USEPA) approved that standard to protect the
beneficial use of "water used for production of wild rice" during periods
damage by high sulfate levels." (Minn. R. 7050.0224, subpart 2).

Following the development of a detailed research protocol in 2011, in 2012 the
groups of scientists at the University of Minnesota Duluth and Twin Cities undertook the Wild Rice
Standards Study. The Study's main hypothesis was that wild rice is impacted by sulfate via the conversion
sulfate to sulfide in the rooting zone. Data collection was completed in December 2013 and
documented in individual reports from the researchers (see Table 1 for Study components) of

During January and February 2014, MPCA staff analyzed and integrated the Study results, the data as a who
gained input from the Wild Rice Standards Study Advisory Committee; and reviewed existing monitoring
data, other relevant scientific studies/information, and the original basis for the wild rice sulfa
develop findings and preliminary recommendations regarding the existing standard. In evaluating the existing s
standard, the MPCA has the responsibility of demonstrating that any standard recom
have a scientific basis and would protect the beneficial use of "water

Findings and Preliminary Recommendations Regarding the Wild Rice Sulfate St

Key Findings:

1. **Sulfate is not directly toxic to wild rice.** Both the MPCA Study and a study commissioned by the Minnesota Chamber of Commerce support this conclusion. However, sulfate in
   converted by bacteria to sulfide in the rooting zone (see Figure 1) of wild rice
2. **Sulfide is toxic to wild rice.** The MPCA Study demonstrated that elevated sulfide concentrations w
   toxic to wild rice seedlings. Hydroponic experiment data showed deleterious effects of
   seedling plant growth when sulfide exceeded the range of 150 to 30
3. **Sulfide in the sediment is affected by the amount of sulfate in**
   iron in the sediment. Data from a majority of the field sampling sites show that the range
   µg/L sulfide in sediment is related to a column water concentration of sulfate between 4.3 and 16.2
   mg/L. This range illustrates that conditions at some of the field sites are more effectiv
   converting sulfate to sulfide, in part due to the availability of iron in the (see Figure 1)

Preliminary Conclusions and Recommendations:

1. **The 10 mg/L sulfate standard is needed and reasonable to protect wild rice product**
   driven sulfide toxicity. The MPCA will also consider including a sediment sulfide
   component of this water quality standard, the sulfide range of 150 to
2. **The 10 mg/L wild rice sulfate standard should continue to apply.** Analysis of
   the field data does not support placing lakes and streams in separate classes; the availability of iron, separate from
   water body type, appears to be the key controlling factor of sulfide concentration in
3. **Site specific standards expected for some waters.** Considerable data suggest that in some
   development of site specific standard would be protective of wild rice production. This is

occur in waters where the sediment iron is elevated and therefore a ... concentration may not result in a sulfide sediment concentration above ... µg/L. There are also data to suggest site specific standards lower than 10 mg/L may be needed ... is more efficiently converted to sulfide.

4. **MPCA will continue to explore if the sulfate standard is needed to protect wild rice grown in paddies for production.** The Study data do not suggest that wild rice grown in paddies is less susceptible to ... elevated sulfide. However, the water management practices associated with paddy wild rice production likely reduce the potential for sulfide production in the sediment ...

5. **MPCA does not currently have a recommendation regarding the "period ... to sulfate effects, but will continue to analyze data to further explore this question.** The sediment incubation experiments data show that sulfate can be converted to sulfide in ... conditions, and that sediment sulfide concentrations decrease once sulfate concentrations ... overlying water decrease. This is a complex interaction and more data ... recommendations can be developed about this important question; any reco... to consider site specific factors that affect this question.

6. **Consideration should be given to changing the use class of wild ...** The MPCA is considering moving the wild rice sulfate standard from Class 4 where ... creating a new subclass to clarify that the standard is designed to protect ... wild rice grains for consumption by humans and wildlife. The MPCA ... "water used for production." The MPCA has received comments suggesting that this is not the best descriptor for natural stands of wild rice that provide bene...

Next Steps

- In late March, MPCA will meet with the Wild Rice Sulfate Standards ... Tribes in separate meetings to get their feedback on the Findings and MPCA Preliminary Recommendations. MPCA will also continue to seek feedback from USEPA ...
- MPCA technical staff will continue to develop and assemble material ... that will be used in wild rice rulemaking. Further analysis of results ... experiments and sediment incubation study will also continue. MPCA will, as appropriate, refine recommendations based on the input received and this continued analysis.
- The MPCA is contracting for a scientific peer review of the wild rice study reports ... aspects of the MPCA's preliminary recommendations and rationale about wh... current 10 mg/L wild rice sulfate standard is warranted, and the nature of the change. The peer review panel will likely convene in late spring 2014 and will include the opportunity for i... stakeholders/members of the public to address the panel.
- In a parallel effort, MPCA is developing a framework to identify the factors that will help identify the spec... "water used for production of wild rice." These factors will be used by MPCA to make determinations ... inform rulemaking to identify specific waterbodies as "water used for production of wild rice" in ... Minnesota Rules Chapter 7050. The goal is to put these factors out for public comment period in March 2014. Comments received will be used to ...
- Any proposed change to the wild rice standard would be adopted into Minnesota's water ... standard rule (Minnesota Rules Chapter 7050) in accordance with the re... Administrative Procedures Act and would require the approval of the US... for having the rule package ready for public notice and comment

Considerations

- As a result of the Wild Rice Sulfate Standard Study and other data much better understanding of the relationship between wild rice, sulfate in the water column, and sulfide and iron in sediment porewater. This includes hypothesis that sulfate is not directly toxic to wild rice, but is co rice (this is supported by hydrology and field data).
    - This enhanced understanding is very important because it helps exp waterbodies have elevated sulfate concentrations and apparently healthy most waterbodies that have had successful beds have relatively low sulfate
    - This enhanced understanding – which MPCA did not have – prior to the in implementing the wild rice sulfate standard. This will be parti need for specific standards and developing such standards.
- Any changes to the current wild rice sulfate standard The wild rice Act requires implementation of the existing standard while through the administrative process and USEPA approval.
- The MPCA's water permitting approach for the current wild rice sulfate stan
    - Where elevated discharge sulfate levels are suspected but no sulfa discharge monitoring requirements are added to NPDES permits as they co reissuance every five years.
    - If discharge data collected during the permit cycle indicate a potential to sulfate standard for wild rice, and it is determined that the production may be affected, a discharge limit will be added to
    - If discharge limits cannot be met immediately a schedule of compl permit to allow steps such as evaluation of treatment technologies, d funds, and construction.
    - The compliance schedule will contain a requirement that the facility compliance with limit as soon as possible or consistent with the applica for permit reissuance.
        - It is important to note that the sulfate discharge limit incl identical to the wild rice sulfate standard. When setting disc variables such as the receiving water and distance betwee point and the water used for production of wild rice. Th the standard is achieved at the water used for production.
    - Note that in accordance with federal law, and variances are typ allowed for new dischargers, which must meet the effluent limit operations.

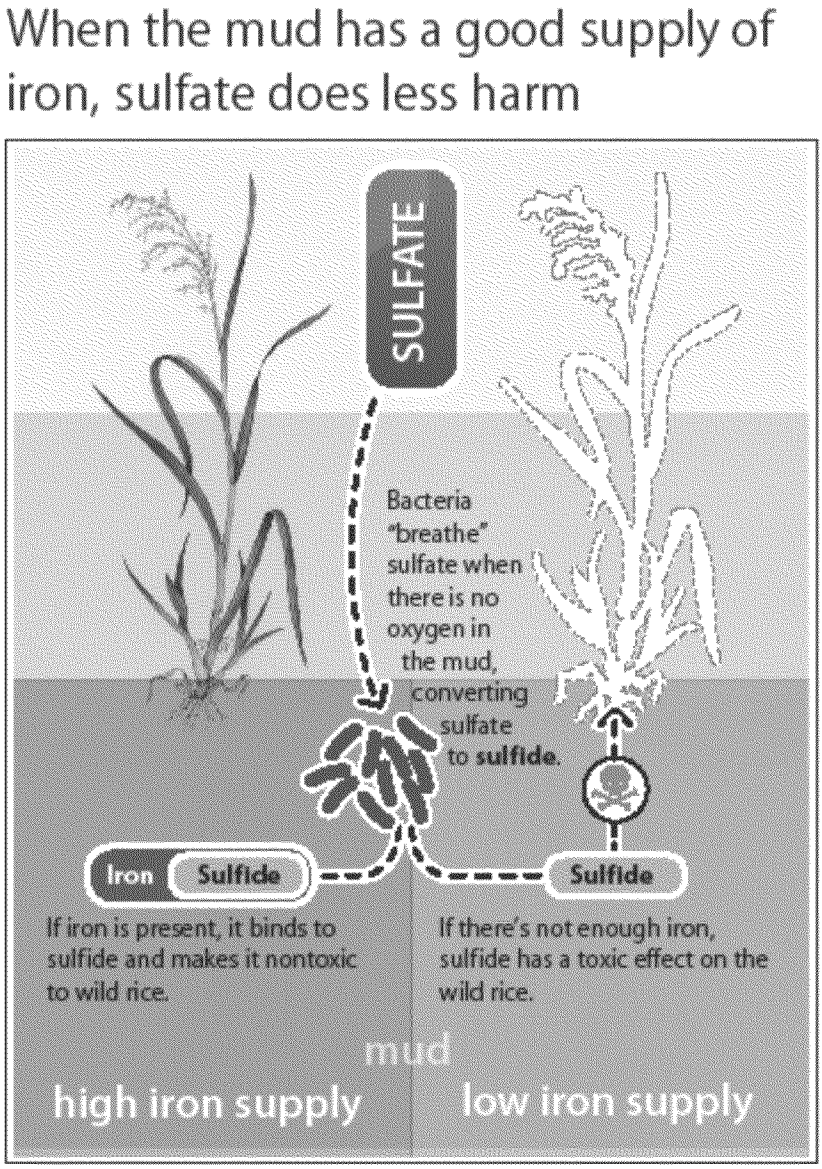
- Implementation of the existing standard does not preclude permitted facil specific wild rice sulfate standard. The MPCA can specify the k standards immediately, where conditions indicate that such a standard exploring options for addressing sulfate efficiently

Table □ð 1. □ð Purpose, □ð strengths, □ð and □ð limitations □ðof □ð Study □ð components.

	Field □ð Survey	Laboratory □ð Hydroponic □ Experiments □ð		Outdoor □ð Container □ð Experiments	Collection □ð a Analysis □ð o Rooting □ð Zor Depth □ð Profil	Sediment □ð Incubation □ð Laboratory □ð Experiments
	□ð	Sulfate (SO_4) □	Sulfide (H_2S) □	□ð	□ð	□ð
Main □ð Purpose	Expand □ð understanding □ð environmental □ð conditions □ð correlated □ð witl presence/ □ð absence □ð of □ð rice.	Evaluate □ð effects □ð of □ð sulfate □ð on □ rice □ð seed □ð germination □ð and □ð growth sprouts. □ð □ð	Evaluate □ð effe of □ð sulfide □ð wild □ð rice □ð germination □ð and □ð growth sprouts. □ðð □ð	Evaluate □ð effects □ð of □ sulfate □ð on □ rice □ð plants over □ð full □ð cycle, and □ð multiple □ð yea	Characterize □ð sulfate, □ð sulfi and □ð iron □ð rooting □ð zone wild □ð rice □ð container □ð experiments □ð and □ð field □ð	Evaluate □ð effe of □ð temperatu on □ð movemen of □ð sulfate □ð and □ð out □ð underlying □ð sediment.
Endpoints	Concentrations □ð of □ð chemicals surface □ð water rooting □ð zone (e.g. □ð & □ð vs. □ð wild □ð ric occurrence).	Growth □ð of □ rice □ð sprouts □ð (biomass, □ð roo & □ð shoot □ð elongation). □ð Germination □ð rate □ð of □ð se	Growth □ð of □ rice □ð sprouts (biomass, □ð roo & □ð shoot □ð elongation). □ð Germination □ð rate □ð of □ð se	Growth □ð of □ rice □ð (biomas plus □ð number weight □ð of □ seeds). Sulfide □ð concentrations in □ð rooting zone.	Concentrations of □ð sulfate, □ sulfide □ð and iron □ð in □ð porewater. □ð	Sulfate □ð concentrations in □ð overlying water □ð over time; □ð, SO_4, □ð iro H_2S, □ð & □ð ar tracers □ð in □ð sediment □ð porewater. □ð Simple □ð model
Key □ð Strengths	Most □ð reflective of □ð actual □ð environmental □ð conditions. □ð Multiple □ð wild rice □ð stands □ð breadth □ð of □ð characteristics □ð sampled. □ðð	Controlled □ð dose-response experiment. □ð Controlled □ð exposure □ð to known □ð concentrations of □ð SO_4	Controlled □ð dose-response experiment. □ð Controlled □ð exposure □ð to known □ð concentrations of □ð H_2S □ð	Controlled □ð dose-response experiment. □ð Includes □ð natural □ð sediment □ð matrix □ð as rooting □ð environment. Involves □ð enti growth □ð cycle multiple □ð yea	Provides □ð additional □ð da to □ð understan and □ð interpre container □ð experiments □ð and □ð field □ð	Controlled □ð experiment □ð with □ð natural sediment □ð and water. □ð
Key □ð Limitations	Least □ð controlle Annual □ð visit most □ð sites, □ 3x/year □ð for □ subset. □ð Not □ð definitive cause and □ð effect.	Only □ð evaluate early □ð growth stages. □ð Leading □ð hypothesis □ð is that □ð sulfate converted □ð to sulfide, □ð which is □ð directly	Only □ð evaluate early □ð growth stages. □ð Unable □ð to □ simultaneously keep □ð roots anaerobic □ð & shoots □ð aerob	Full □ð effect sulfate □ð may take □ð longer than □ð several years □ð to □ð realize. □ð No groundwater □ movement.	Utility □ð lies the □ð integrati of □ð this □ð d with □ð other Study □ð components, □ not □ð in □ð th set □ð alone.	Provides □ð preliminary □ð assessment □ð o sediment □ð fro two □ð sites □ð may □ð inform is not □ð fully transferrable □ð other □ð sites. groundwater □ð movement. □ð N wild □ð rice □ð grown.

□ð

Figure □ð1. □ð The □ð relationship □ð between □ð sulfate, □ð sulfide □ð and □ð iron □ð in □ð surface □ð water □ð and □ð sedir



The iron-sulfide battle
The amount of iron and sulfide are dynamic and one affects the other. If enough new iron is flowing into the mud (e.g. via groundwater), then even a lake or stream with high sulfate levels can support wild rice. On the other hand, enough sulfate can overwhelm the supply of iron and make sulfide levels toxic.

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